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Status of the Community Health and Environmental Surveillance System (CHESS)

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Prepared for

United States House of Representatives
Committee on Science and Technology

Prepared by

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Washington DC 20460

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November 1980

STATUS OF THE COMMUNITY HEALTH AND ENVIRONMENTAL SURVEILLANCE SYSTEM (CHESS)

REPORT

TO THE

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE

ON

SCIENCE AND TECHNOLOGY

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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Status of Community Health and Environmental Surveillance System (CHESS)

I. Introduction

This report has been prepared in response to a request by the U.S. House of Representatives' Committee on Science and Technology which appears in House Report No. 96-959, page 61. The Committee requested that the Administrator of EPA:

> "...immediately (within 90 days) prepare and submit to the Committee a comprehensive and substantial report on the status of the analysis of CHESS data and on any results obtained with particular emphasis on methods used to assure the soundness of any results. The report should also describe any pressure the Agency has received to force them to publish or not publish any CHESS results."

From 1969 to 1975 EPA conducted a series of epidemiologic studies on the health effects of air pollution. These studies, together known as the Community Health and Environmental Surveillance System (CHESS) studies, were performed in several cities across the United States. Several different populations and pollutants were studied. In 1974 EPA published a monograph on the health effects of sulfur oxides (hereafter called the CHESS monograph) which reported results from the early years of the CHESS studies. After unfavorable publicity about the CHESS studies, subcommittees of the House Committee on Science and Technology conducted an investigation into the technical adequacy of the CHESS studies in 1976. In their Investigative Report the subcommittees

made seventeen recommendations about the analysis and use of those studies and of CHESS data generally.[1]

In the Environmental Research, Development and Demonstration Authorization Act (Research Authorization Act) of 1978, Congress directed that the Administrator of EPA implement the recommendations of the Investigative Report, unless for any specific recommendation he determines that implementation has already occurred, that the quality of research would not thereby be enhanced, or that funding is unavailable (in which case funding is to be sought from Congress).[2] EPA's implementation of these recommendations is documented in reports to Congress by the Administrator (EPA Research Outlook, 1978 and 1979) and the EPA Science Advisory Board (Report of the Health Effects Research Review Group, February, 1979), which are reproduced in the CHESS addendum (supra, note 1). Among the pertinent recommendations in the Investigative Report, Recommendation 6(a) directs that unanalyzed CHESS data be examined by year and that analysis be carried out only on those data that appear to have a higher degree of validity than the 1969-1971 data used as a basis of the 1974 CHESS Monograph. Recommendation 6(b) is that completed analyses be published in traditional scientific peer-reviewed journals, and not simply in monograph form. Recommendation 3(b) is that EPA not utilize the CHESS monograph as a source of quantitative data supportive of standards without explicit qualification.

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[1] The Investigative Report ("The Environmental Protection Agency's Research Program with Primary Emphasis on the Community Health and Enviornmental Surveillance System CHESS): An Investigative Report, November 1976") is available as part of an addendum to the CHESS monograph. The addendum (EPA 600/1-80-021, April, 1980) was announced to the public in the Federal Register of April 2, 1980 (45 FR 21702). That addendum was published pursuant to Recommendation 3(c) of the Investigative Report, and is being forwarded to the House Committee on Science and Technology with this report.

[2] Section 10 of the Research Authorization Act of 1978, P.L. 95-155, November 8, 1977 (42 U.S.C. §4361b).

II. Status of CHESS Data Analyses and Results Obtained

In implementing the recommendations from the Investigative Report and in assuring the validity of data analyses and the quality of results obtained EPA has taken the actions described below. Tables A and D in Appendix A show respectively the current status of CHESS data sets and publications to date from those data sets. EPA has recently also discussed these matters at a public meeting of the Clean Air Scientific Advisory Committee (CASAC) of the EPA Science Advisory Board (SAB) on August 20-22, 1980, in Arlington, Virginia. CASAC was established under Section 109(d)(2) of the Clean Air Act (42 U.S.C. §7409(d)(2)) to provide advice to the Administrator on such matters.

The status of CHESS data analyses and methods used to assure soundness of both health effects and aerometric data are described below. Thereafter, the review and analysis of CHESS data by both EPA and others, and results obtained, are discussed.

A. Validation of the Health Effects Data

An additional data quality assurance procedure has been applied to the health questionnaire information. This technique involves additional checking to confirm that the data on the computer data tape files are consistent with the original source document responses. The major advantage of this approach is that any errors introduced into the data set during the data processing phase can be identified and corrected. The successful application of this procedure to 61 CHESS data sets during 1977-1979 required 32 person-years of effort and $140,000 of computer time by EPA's Health Effects Research Laboratory in Research

Triangle Park, North Carolina (HERL/RTP) (see Table C in Appendix A). Since 1976, analysis of CHESS data has been performed only after the relevant data sets have undergone this additional quality assurance procedure. A relevant report is:

> Chamblee, CP: USE OF STATISTICAL SAMPLING IN VALIDATING HEALTH EFFECTS DATA. In: Data Validation Conference Proceedings, EPA Report No. EPA 600/9-79-042, pp. 31-38, September, 1979.

With this validation step alone the remaining CHESS data are of demonstrably greater reliability than those used as the basis for the 1974 CHESS monograph. EPA has determined that such data, including those being analyzed under contract at the University of North Carolina (see II. C., infra), are acceptable for further analysis in accordance with Recommendation 6(a) of the Investigative Report. Of course, the simple fact of comparatively greater reliability does not assure that the data or subsequent analyses are of such reliability as to be useful for standard-setting or other purposes. Rather, the general overall reliability and validity of CHESS data and procedures are subject to public and scientific scrutiny at the time CHESS studies are published in peer-reviewed journals or are proposed to be included in criteria documents or to be used as a basis for standards.

Beyond the aforementioned data validation procedures, the validity of the statistical analysis was carefully reviewed. The Investigative Report has little criticism and, in fact, some praise for the EPA analysis of the cross-sectional studies. There was more criticism of the panel data analysis involving temporal comparison of asthmatic attacks or cardiopulmonary

symptoms. EPA agreed with this assessment and funded resource grants which have been successful in developing improved analysis methods for these studies. Relevant reports are:

Whittemore, AS; Keller, JB: ASTHMA AND AIR POLLUTION: A QUANTITATIVE THEORY. Energy and Health, Proceedings of SIMS Conference, Alta, Utah, June, 1978. N. E. Breslow and A. S. Whittemore, Editors. Philadelphia: SIAM, 1979.

Korn, EL; Whittemore, AS: METHODS FOR ANALYZING PANEL STUDIES OF ACUTE HEALTH EFFECTS OF AIR POLLUTION. Biometrics 35(4), December, 1979.

Whittemore, AS; Korn, EL: ASTHMA AND AIR POLLUTION IN THE LOS ANGELES AREA. A. Jour. Public Health 70(7): 687-696, July, 1980.

As described previously, validation of 61 data sets has been completed. Four data sets not to be validated involve "episode" studies. They are New York City (1971-72), the Southeast area (Birmingham and Charlotte, 1971-72), Chattanooga (1971-72), and California (1973). There are three major considerations underlying the decision that these data sets not be validated or subject to full analysis:

(1) As the initial episode studies were analyzed (New York City and Birmingham-Charlotte, 1970-71), concern for a systematic reporting bias in the study respondents became evident, opening any conclusions to serious question.

(2) Although the studies were designed to take advantage of opportunities to study episodes of high air pollution, in retrospect when the air quality data were more carefully examined there were frequently only marginal exposure differences between the time periods studied.

(3) The data from these studies are the most difficult, logistically, to retrieve and validate.

B. Validation of the Aerometric Data

The aerometric data from the early CHESS studies in the 1974 monograph were also criticized in the Investigative Report. One of the major limitations identified was the difficulty in estimating prior air pollution exposures of the study participants, because the monitoring data base over time was either very short or nonexistent. The later CHESS studies necessarily benefit from the availability of a longer historical record of pollution exposure information.

The Investigative Report further included statements regarding possible correction procedures that might be employed to ascertain more valid aerometric estimates than those provided by the original CHESS monitoring efforts. These statements included references to the use of aerometric data from local or state air monitoring systems where they existed side by side with the CHESS monitoring stations. Other statements were made in the Report to the effect that more valid estimates of certain air pollutant levels monitored by the CHESS system could be obtained by correcting original reported values upward to revised levels likely to have existed, taking into account estimated maximum likely error ranges for such measurements.

Personnel from the EPA Environmental Monitoring and Support Laboratory in Research Triangle Park, North Carolina (EMSL/RTP) performed validation of aerometry data for the study locations and years associated with the health data sets validated as described above (in II. A.). This aerometry validation, completed in 1978, consisted of inspecting for consistency

both data collection records and previously discarded air quality measurements (those not meeting pre-specified criteria established for determination of acceptable quality aerometric data[3]).

Although some deletions or omissions have been identified in the aerometry data, these data gaps are believed by EPA's EMSL/RTP and HERL/RTP to be few and are therefore believed to exert little effect upon long-term data averages (quarterly, annual, etc.) needed for analysis of health effects associated with long-term exposures (acute respiratory disease, chronic respiratory disease, lower respiratory disease, and pulmonary function studies). These deletions or omissions are believed to be significant enough to cast doubts upon the reliability of results from analyzing health data sets based on short-term (daily, weekly, monthly) exposures (asthma and cardiopulmonary panels and episode studies).

Finally, efforts have been made to correct many of the deficiencies in collection and analysis of aerometry data associated with the early CHESS studies. The utilization of the Community Health Air Monitoring Program (CHAMP) system with automated data collection capabilities, for example, permitted more extensive aerometric data validation with the later data sets (post-CHESS).

C. Further EPA Review and Analysis of CHESS Data

Subsequent to release of the Investigative Report in 1976, each of the previously unpublished CHESS data sets underwent critical examination by EPA,

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[3]The criteria for acceptable quality aerometric data as well as descriptions of monitoring methods are contained in a January, 1976, EPA publication, Community Health and Environmental Surveillance System Air Pollution Monitoring Handbook: Monitoring Methods (EPA 600/1-76-011).

involving each point discussed above, before any further analysis was initiated. In addition, once analysis has been initiated, critical examination continues both by EPA and by contractors hired to perform the analyses. Analysis of one data set, Chattanooga PFT 1973-74, was cancelled after completion of initial validation procedures because of an uncorrectable data coding problem.

EPA entered into a contract with Dr. Carl Shy at the University of North Carolina (UNC) School of Public Health in 1977 to produce reports on 36 CHESS data sets. All the data sets provided to Dr. Shy had been revalidated through the procedures discussed above. (One data set, Chattanooga PFT 1973-1974, was subsequently found to contain coding errors serious enough to warrant its removal from inclusion, as mentioned in the preceding paragraph, bringing the total number of data sets to be analyzed by Dr. Shy to 35.) The contract calls for delivery 36 months from its effective date, September 1, 1977, of 12-21 manuscripts of quality suitable for publication at a cost to EPA of approximately $590,000 over the three-year period. Dr. Shy has requested an extension of the contract period at no additional cost to EPA. The sets provided to UNC are identified in Tables B & E in Appendix A of this report. To date, Dr. Shy has forwarded five analyses to EPA for preliminary (pre-publication) review.[4]

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[4] It should be noted that a three-person non-EPA peer review panel recruited by the UNC group reviews all planned publications of the Shy analyses. (See the Report of the Health Effects Research Review Group, republished in the CHESS addendum at p. 206, supra, note 1.) Further, as discussed at the CASAC meeting of August 20-22, 1980, any such analyses will be cited in air quality criteria documents prepared by EPA pursuant to Section 108 (a) (2) of the Clean Air Act (42 U.S.C. §7408 (a) (2)) only if they conform to guidelines approved by CASAC.

D. Review and Analysis of CHESS Data by Others (Outside EPA)

Numerous requests for copies of the CHESS reports and data files have been received and honored by EPA under the Freedom of Information Act or otherwise. Copies of computer tapes containing the data files provided to requestors have been coded in the interest of confidentiality. A list of the 13 individuals and organizations who have made such requests appears in Appendix B.

E. Results Obtained from Analysis of CHESS Data

Appendix C contains a list of published reports which relate to CHESS and to the CHESS data. With one exception, no results from analyses of the validated data sets have yet been published by EPA or its contractor.

The single exception mentioned above is a report by Drs. Shy and Love given at a meeting of the Air Pollution Control Association (APCA) in Hawaii in 1979 and subsequently published in proceedings of that meeting. (See Appendix C, I. B. 25.) The results of that study were derived from initial CHESS analyses performed on the Chattanooga acute respiratory disease (ARD) 1971-72 and 1972-73 data sets under the EPA contract with Dr. Shy.

The study results were included in the July, 1979, Second External Review Draft of the EPA NO_x Criteria Document. As part of public comments on the NO_x document draft and in subsequent meetings with EPA, the Utility Air Regulatory Group (UARG), the Electric Power Research Institute (EPRI), and the Edison Electric Institute (EEI) commented on the Chattanooga ARD 1972-73 study. [That study was one of several conducted in the CHESS program to follow-up earlier (1968) studies in Chattanooga which were performed by Shy and which in part formed the basis for the 1970 National

Ambient Air Quality Standard (NAAQS) for NO_x.] UARG, EPRI, EEI, and their statistical consultants, Roth and Associates, questioned the validity and interpretation of both the 1968 Shy Chattanooga studies and the 1972-73 Chattanooga ARD study, as well as British indoor pollution studies. Roth and Associates were unable to duplicate the Shy and Love (1979) results, despite use of the same statistical analyses of data from copies of the 1971-72 and 1972-73 Chattanooga ARD data sets on computer tapes obtained from EPA. Roth noted problems ascertaining the criteria employed by Shy and Love to exclude subjects from analyses or to assign subjects to study groups according to demographic characteristics.

Roth and Associates representatives met in Chapel Hill, North Carolina, with Shy's group at the UNC School of Public Health in June, 1980. The two groups compared the contents of their data analysis files as a first step toward identifying sources of discrepancies in their results. Data handling errors were discovered which had occurred in transferring data from EPA's validated data files to the working analysis files of Shy's group. Other potential problems were noted with the UNC analyses concerning assessment of possible confounding effects due to racial, socioeconomic, or other factors. The UNC group agreed (1) to correct the aforementioned errors in data handling, (2) to reexamine their assessment of confounding factors or co-variables in reanalyzing the 1972-73 Chattanooga ARD data, and (3) to provide clear documentation of criteria employed for exclusion or classification of subjects and of other considerations in performing the reanalysis. In the meantime, discussion of the published Shy and Love (1979) analyses has been deleted

from a revised NO_x criteria document draft. These developments were also discussed publicly at the August, 1980, meeting of the Clean Air Scientific Advisory Committee (CASAC).

III. Pressure to Force EPA to Publish or Not to Publish CHESS Results

Since the release of the 1976 Investigative Report on CHESS and enactment of the Research Authorization Act of 1978, industrial and environmental interest groups have taken actions which could be construed as exerting pressure on EPA to publish or not to publish CHESS data. The smelting industry, for instance, has long criticized the CHESS studies. Many groups have also submitted written comments concerning CHESS during reviews of the various draft NO_2 criteria documents, and the first external review draft of a revised criteria document for particulate matter and sulfur oxides (PM/SO_x) which was released in April, 1980. Three main interest groups or coalitions, however, can be identified as having recently exerted pressures to affect EPA's publication or possible use of CHESS studies: (1) the American Iron and Steel Institute (AISI) and member steel companies; (2) the Utility Air Regulatory Group (UARG) and associated organizations such as the Electric Power Research Institute (EPRI) and the Edison Electric Institute (EEI); and, to a lesser extent, (3) the Natural Resources Defense Council (NRDC).

A. AISI/Steel Company Actions

AISI and member steel companies have brought a succession of legal actions against EPA in federal district court in Pittsburgh in connection with EPA's current review and revision of the criteria document for particulate matter under Section 108 of the Clean Air Act (42 U.S.C. § 7408). Some of these actions

have involved, directly or indirectly, the analysis and possible future regulatory use of CHESS studies. These and related AISI actions include:

(1) The taking of 41 depositions on CHESS and other subjects from EPA staff members, Drs. Carl Shy and Gory Love at UNC, and other scientists as part of discovery proceedings connected with AISI vs. Costle, No. 78-92 (W. D. Pa.). In connection with the 2 1/2 years of litigation, AISI has demanded the deletion of any reference to CHESS analyses from the revised PM/SO_x criteria document now in preparation, and assurances that CHESS analyses would not be used in considering revision of the primary (health) National Ambient Air Quality Standard for particulate matter. The lawsuit recently was settled, without terms affecting EPA's analysis or possible use of CHESS.

(2) The meeting of AISI representatives and attorneys with Dr. Stephen Gage, EPA Assistant Administrator for Research and Development, and other ORD officials to discuss CHESS-related issues in December, 1979. The meeting followed EPA's refusal to terminate Dr. Shy's contract, as requested by AISI in a letter to the Administrator of April 18, 1979. AISI attorneys repeated demands that all CHESS results be excluded from consideration in the PM/SO_x document and that the Shy contract be terminated.

(3) The initiation by AISI and member steel companies in February, 1980, of further legal proceedings against EPA seeking (1) the suspension of Dr. Shy's contract, and all other epidemiologic research funded by EPA; (2) suspension of EPA's analysis of any CHESS data; and (3) a prohibition against EPA's use of any CHESS data in current EPA regulatory activities, pending

court-supervised "implementation" of Recommendations 3, 6, and 10 of the Investigative Report. AISI vs. Costle, No. 80-218 (W. D. Pa.)

B. UARG/EPRI/EEI Actions

Without resort to the courts, several electric industry groups have brought to the attention of EPA new information and constructive criticism regarding various CHESS studies. The utility interest groups and their statistical consultants, Roth and Associates, have had meetings and communications concerning CHESS both with EPA officials and with Drs. Shy and Love at UNC. They have discussed the 1972-73 Chattanooga ARD study (see II. E. above) and other CHESS studies concerning NO_x, PM, and SO_x. Recently, UARG submitted comments to EPA on the April, 1980, PM/SO_x criteria document draft, including substantive analyses of CHESS. EPA has also sought advice from the Science Advisory Board (SAB) Clean Air Scientific Advisory Committee (CASAC) concerning UARG's CHESS information, and the possible use of CHESS data for standard setting purposes.

C. NRDC Actions

Actions which have been taken by NRDC relative to publishing and using CHESS data are:

(1) Telephone conversations between NRDC representatives and EPA officials in which NRDC said that important information could be derived from certain CHESS studies (including some unpublished analyses) concerning PM/SO_x health effects and that the CHESS studies should not be universally excluded from the document in response to the AISI lawsuit.

(2) A petition filed by NRDC with the Administrator of EPA requesting that a criteria document be prepared reviewing scientific evidence for setting a fine particle standard. Several CHESS studies were cited as examples of scientific evidence supporting the NRDC petition.

(3) Concerns expressed regarding the propriety of EPA meeting with industry groups to receive new information on CHESS. In a November, 1979, public meeting attended by NRDC, EPA had offered to meet with any party at any time to discuss new information related to CHESS. In response to NRDC's recently expressed concerns, EPA has agreed to inform NRDC of any future CHESS-related meetings with other parties so that NRDC may attend if it so desires.

APPENDIX A

Table A
CHESS STATUS

Summary:

Total Data Sets	83
Data Sets Published	23*
Total Publications Related to CHESS (see Appendix C)	57*
Data Sets Validated	61
Data Sets Provided to the University of North Carolina for Analysis	36†
Data Sets Not Planned to be Analyzed or Published	27

*Total includes data sets "published" in 1974 CHESS Monograph and other EPA technical publications as well as some in peer-reviewed publications or journals.

†Discovery of coding errors in one data set has reduced the number of data sets to be analyzed to 35, as discussed in Section II. C. of this report.

Table B (see Key, p. 19)
CURRENT STATUS OF CHESS DATA SETS

New York

1 CRD 1970[a,b]
2 CRD 1972[c,d,f]
3 LRD 1972[b,c,d]
4 PFT 1970-71[a,b]
5 PFT 1971-72[c,d]
6 PFT 1972-73[c,d,f]
7 PFT 1973-74[c,d,f]
8 PFT 1974-75[c,d,f]
9 ARD 1970-71[a,b]
10 ARD 1971-72[c,d,f]
11 ARD 1972-73[c,d,f]
12 Asthma 1970-71[a]
13 Asthma 1971-72[c,e,g]
14 Asthma 1972-73[c,e,g]
15 Asthma 1973-74[c,d,e,g]
16 Asthma 1974-75[c,d,e,g]
17 Cardiopulmonary 1970-71[a]
18 Cardiopulmonary 1971-72[b]
19 Cardiopulmonary 1972-73[c,e,g]
20 Cardiopulmonary 1973-74[c,d,e,g]
21 Cardiopulmonary 1974-75[c,d,e,g]
22 (NJ) CRD 1971[c,f]
23 (NJ) LRD 1971[c,f]
24 Episodes 1970-71[b]
25 Episodes 1971-72[h]

Utah

26 CRD 1970[a,b,c]
27 LRD 1970[a,b,c]
28 PFT 1971-72[c,d,f]
29 PFT 1972-73[c,d,f]
30 PFT 1973-74[c,d,f]
31 PFT 1974-75[c,d,f]
32 ARD 1971-72[c,d,f]
33 ARD 1972-73[c,d,f]
34 Asthma 1971[a]
35 Asthma 1971-72[c,e,g]
36 Asthma 1972-73[c,e,g]
37 Asthma 1973-74[c,d,e,g]
38 Asthma 1974-75[c,d,e,g]
39 Cardiopulmonary 1971-72[c,e,g]
40 Cardiopulmonary 1972-73[c,e,g]
41 Cardiopulmonary 1973-74[c,d,e,g]
42 Cardiopulmonary 1974-75[c,d,e,g]

Table B (continued)

Birmingham-Charlotte (Southeast)

43 CRD 1971[c,f]
44 LRD 1971[b,c]
45 PFT 1971-72[b,c]
46 PFT 1972-73[c,d,f]
47 PFT 1973-74[c,d,f]
48 PFT 1974-75[c,d,f]
49 ARD 1970-71[c,d,f]
50 ARD 1971-72[c,d,f]
51 ARD 1972-73[c,d,f]
52 Asthma 1971-72[c,e,g]
53 Asthma 1972-73[c,e,g]
54 Asthma 1973-74[c,d,e,g]
55 Asthma 1974-75[c,d,e,g]
56 Episodes 1970-71[b]
57 Episodes 1971-72[h]

Chattanooga

58 CRD 1971[c,f]
59 LRD 1971[c,f]
60 CRD 1973[c,d,f]
61 LRD 1973[c,d,f]
62 PFT 1971-72[b]
63 PFT 1972-73[c,d,f]
64 PFT 1973-74[c,d,h]
65 ARD 1971-72[b,c,d,f]
66 ARD 1972-73[b,c,d,f]
67 Asthma 1972-73[b,c]
68 Episodes 1971-72[h]

California

69 CRD 1971[c,d,f]
70 LRD 1971[c,d,f]
71 PFT 1972[c,d,f]
72 PFT 1972-73[c,d,f]
73 PFT 1973-74[c,d,f]
74 PFT 1974-75[c,d,f]
75 ARD 1972-73[c,d,f]
76 Asthma 1972-73[b,c,e]
77 Asthma 1973-74[b,c,d,e]
78 Asthma 1974-75[b,c,d,e]
79 Cardiopulmonary 1973-74[c,d,e,g]
80 Cardiopulmonary 1974-75[c,d,e,g]
81 Episodes 1973[h]

Montana-Idaho

82 CRD 1970[a,b]
83 LRD 1970[a,b]

Table B (Key)

a Published in 1974 CHESS Monograph

b Published elsewhere

c Additional questionnaire quality assurance has been performed

d More extensive air monitoring data base has been applied for exposure assessment

e Improved methodological development of statistical analysis has been applied

f Additional analyses still in progress by UNC

g No additional analyses have been initiated to date

h No analyses are warranted because of poor data set quality

A very brief description of each CHESS health indicator follows:

Chronic respiratory disease (CRD). Adult chronic respiratory disease prevalence was estimated by a self-administered questionnaire adapted from that used by the British Medical Research Council. The questionnaire inquired whether the subject coughed and produced phlegm for at least three months of the previous year. These studies compared CRD prevalence in otherwise similar communities selected for their air pollution gradient. The CRD community rates can be adjusted for important covariates such as age, race, cigarette smoking, socio-economic status, and occupational exposure to dust or fumes.

Lower respiratory disease (LRD). The questionnaire ascertained retrospective information from mothers concerning the number of pneumonia, croup and bronchitis episodes experienced by their children under age 12

Table B (continued)

during the previous three years. These illness rates were compared across communities. The LRD rates can be adjusted for major covariables of age, sex, and socioeconomic status.

Acute respiratory disease (ARD). Telephone interviewers made biweekly calls to mothers of families enrolled in the study to inquire whether any family member had developed upper or lower respiratory illness in the preceding two weeks, and, if so, whether a doctor had been consulted and how many days of restricted activity had eventuated. The major response variables were the number of respiratory illnesses per 100 person-weeks exposure (the attack rate) and the severity score, which reflected physician visits, fever, and restricted activity. These studies were performed for about 40 weeks. Rates for each type of family member may be compared across communities. Adjustment to the ARD rates can be made for age, race, cigarette smoking, and socioeconomic status.

Pulmonary function tests (PFT). The ventilatory function of elementary school children was measured using a peak flow meter three times each year, once each in the fall, winter, and spring. Major covariates were age and height. The average rates, appropriately adjusted, were compared across communities.

Asthma panel studies. Selected asthmatic subjects kept daily diaries of their asthma attack experience. The daily fluctuations in the panel's illness experience was compared to daily fluctuations in air pollutant and meteorologic variables such as sulfur dioxide, nitrogen

Table B (continued)

dioxide, particulates, ozone, sulfates, nitrates, temperature, and humidity. The time series analyses can be performed by various techniques which can appropriately resolve the inherent analysis complications, such as frequent changes in panel composition and daily dependence of the response variable.

Adult (cardiopulmonary) panel studies. Cardiopulmonary symptoms were reported daily by a panel of adult subjects. Daily symptom rates for these panels were compared with daily fluctuations in the levels of the same pollutant and meteorologic variables listed above with the asthma studies. Appropriate time series analyses, similar to those used in the asthma studies, can be performed.

Episode studies. Minor irritation symptoms such as eye irritation, chest and throat discomfort, etc., were reported by volunteer panelists during time periods of elevated air pollution and during "control" periods of normal pollution levels. Differences in reported symptom rates between time periods were tested for significance by nonparametric methods.

Table C
CHESS DATA SETS VALIDATED
(For definitions of terms, see Key, Table B)

	Study Areas	Completed
1.	CRD Chattanooga 1971	09/06/77
2.	LRD Chattanooga 1971	09/06/77
3.	ARD Chattanooga 1971-72	09/06/77
4.	ARD Chattanooga 1972-73	09/06/77
5.	ARD Southeast 1970-71	04/22/77
6.	ARD Utah 1972-73	11/01/77
7.	PFT Utah 1971-72	09/29/77
8.	PFT Utah 1972-73	06/15/77
9.	PFT Utah 1973-74	11/23/77
10.	PFT Utah 1974-75	10/17/77
11.	Asthma California 1972-73	05/16/77
12.	Asthma New York 1971-72	02/09/77
13.	Asthma Utah 1971-72	11/23/74
14.	Asthma Southeast 1971-72	11/10/77
15.	Adult Cardiopulmonary New York 1973-74	03/30/77
16.	Adult Cardiopulmonary Utah 1973-74	04/08/77
17.	ARD Utah 1971-72	12/12/77
18.	CRD California 1971	12/23/77
19.	LRD California 1971	12/23/77
20.	ARD California 1972-73	01/30/77
21.	ARD Southeast 1971-72	03/31/78
22.	CRD New Jersey 1971	03/20/78
23.	LRD New York 1971	03/20/78
24.	PFT California 1974-75	03/31/78
25.	CRD Southeast 1971	05/08/78
26.	Asthma California 1973-74	05/10/78
27.	Asthma California 1974-75	05/10/78
28.	PFT California 1972-73	05/18/78
29.	Asthma Utah 1973-74	05/22/78
30.	Asthma New York 1972-73	05/22/78
31.	PFT California 1972	05/31/78
32.	ARD New York 1971-72	06/09/78
33.	Asthma New York 1973-74	06/14/78
34.	CRD New York 1972	06/27/78
35.	Asthma Utah 1974-75	07/05/78
36.	Asthma Southeast 1972-73	07/12/78
37.	Asthma Utah 1972-73	07/13/78
38.	PFT California 1973-74	07/26/78
39.	CRD Chattanooga 1973	08/17/78
40.	LRD Chattanooga 1973	08/17/78

Table C (continued)
CHESS DATA SETS VALIDATED

	Study Areas	Completed
41.	PFT Southeast 1972-73	08/22/78
42.	PFT Chattanooga 1972-73	08/22/78
43.	PFT Southeast 1973-74	08/22/78
44.	ARD Southeast 1972-73	08/25/78
45.	ARD New York 1972-73	08/25/78
46.	Adult Cardiopulmonary California 1974-75	09/15/78
47.	Adult Cardiopulmonary New York 1972-73	09/15/78
48.	Adult Cardiopulmonary New York 1974-75	09/15/78
49.	Asthma Chattanooga 1972-73	09/18/78
50.	Asthma Southeast 1973-74	09/18/78
51.	PFT New York 1973-74	10/06/78
52.	PFT New York 1974-75	10/06/78
53.	Asthma New York 1974-75	10/19/78
54.	PFT Southeast 1974/75	11/06/78
55.	Asthma Southeast 1974-75	11/07/78
56.	Adult Cardiopulmonary California 1973-74	12/08/78
57.	Adult Cardiopulmonary Utah 1972-73	12/08/78
58.	Adult Cardiopulmonary Utah 1974-75	03/01/79
59.	PFT Chattanooga 1973-74	04/24/79
60.	PFT New York 1972-73	06/12/79
61.	Adult Cardiopulmonary Utah 1971-72	05/01/79

Table D
CHESS DATA SETS PUBLISHED (23)
(For definitions of terms, see Key, Table B)

	Study	Study # From Table B	Publication
1.	New York CRD 1970	(1.)	I, V
2.	Utah CRD 1970	(26.)	I, V
3.	Montana-Idaho CRD 1970	(82.)	I, V
4.	Utah LRD 1970	(27.)	I
5.	Montana-Idaho LRD 1970	(83.)	I
6.	New York LRD 1972	(3.)	II
7.	New York ARD 1970-71	(9.)	I, V
8.	New York Asthma 1970-71	(12.)	I
9.	Utah Asthma 1971	(34.)	I
10.	New York Adult 1970-71	(17.)	I
11.	New York Adult 1971-72	(18.)	III
12.	New York PFT 1970-71	(4.)	I, V
13.	Southeast PFT 1971-72	(45.)	II
14.	New York Episodes 1970-71	(24.)	IV
15.	Southeast Episodes 1970-71	(56.)	IV
16.	Chattanooga PFT 1971-72	(62.)	VI
17.	Southeast LRD	(44.)	VII
18.	Chattanooga Asthma 1972-73	(67.)	XIII
19.	Chattanooga ARD 1971-72	(65.)	IX
20.	Chattanooga ARD 1972-73	(66.)	IX
21.	California Asthma 1972-73	(76.)	X
22.	California Asthma 1973-74	(77.)	X
23.	California Asthma 1974-75	(78.)	X

Publications

I. Health Consequences of Sulfur Oxides: A report from CHESS, 1970-1971, EPA-650/1-74-004, May, 1974.

II. Clinical Implications of Air Pollution Research, Proceedings of American Medical Association, Air Pollution Medical Research Conference, 1976.

Table D (continued)

III. Environmental Research, Volume 11, 1976.

IV. Journal of the Air Pollution Control Association, Volume 23, 1973.

V. Archives of Environmental Health, Volume 27, 1973.

VI. EPA Technical Report.

VII. Respiratory Disease in Children Exposed to Sulfur Oxides and Particulates. EPA 600/1-77-043, September, 1977.

VIII. Environmental Research, Vol. 17, 1978.

IX. Recent Evidence on the Human Health Effects of Nitrogen Dioxide. In: Nitrogen Oxides and Their Effects on Health Ann Arbor Science, 1980.

X. Amer. Jour. Pub. Health. 70(7), 1980.

Table E

CHESS DATA SETS PROVIDED TO THE UNIVERSITY OF NORTH CAROLINA UNDER CONTRACT

ACUTE RESPIRATORY DISEASE SURVEYS

1.	New York	1971-1972
2.	New York	1971-1973
3.	Salt Lake Basin	1971-1972
4.	Salt Lake Basin	1972-1973
5.	Chattanooga	1971-1972
6.	Chattanooga	1972-1973
7.	Southeast	1970-1971
8.	Southeast	1971-1972
9.	Southeast	1972-1973
10.	Utah	1972-1973

PULMONARY FUNCTION STUDIES

11.	Salt Lake Basin	1971-1972
12.	Salt Lake Basin	1972-1973
13.	Salt Lake Basin	1973-1974
14.	Salt Lake Basin	1974-1975
15.	Los Angeles Basin	1972
16.	Los Angeles Basin	1972-1973
17.	Los Angeles Basin	1973-1974
18.	Los Angeles Basin	1974-1975
19.	Chattanooga	1972-1973
20.	Chattanooga	1973-1974*
21.	New York	1972-1973
22.	New York	1973-1974
23.	New York	1974-1975

*Data set subsequently withdrawn and deleted from analysis program due to discovery of coding errors in the field.

Table E (continued)

PULMONARY FUNCTION STUDIES		
24.	Southeast	1972-1973
25.	Southeast	1973-1974
26.	Southeast	1974-1975
CHRONIC RESPIRATORY DISEASE SURVEYS		
27.	Chattanooga	1971 (1)
28.	Chattanooga	1973
29.	Los Angeles Basin	1971
30.	Southeast	1971
31.	New York	1972
32.	New Jersey	1971
LOWER RESPIRATORY DISEASE SURVEYS		
33.	Chattanooga	1971
34.	Chattanooga	1973
35.	Los Angeles Basin	1971
36.	New Jersey	1971

APPENDIX B

Current Status of Independent CHESS Analyses

Requestor	Date Provided	Specific Study
Kennecott Copper Corporation (Analyzed by A. D. Little, Inc.)	1974	*Utah Asthma 1971 Utah CRD Utah LRD New York Asthma 1970-71 New York Adult 1970-71 New York CRD 1970 New York PFT 1970
Dr. Donald R. McNeil Department of Statistics Princeton University	1975	(Same as above)
Dr. Neil Roth† Office of Program Evaluation Office of Planning and Management, EPA	1975	(Same as above)
Mr. John Waite Cryptanalytic Computer Sciences, Inc.	1975	New York Asthma 1970-71 Utah Asthma 1971
Mr. Ralph Mitchell Battelle Columbus	1973	New York ARD 1970-71
Mr. John Viren Greenfield, Attaway, and Tyler, Inc.	1975 1977	*New York Asthma 1970-71 *New York Asthma 1971-72 New York CRD 1970
Dr. John Goldsmith California State Dept. of Health	1976	California Asthma, 1972-73
Dr. Edward Faeder So. California Edison, Inc.	1976	*California Asthma, 1972-73

*Report or draft report on reanalyses prepared by requestors. Note that data sets with dates before 1972 were among those discussed in 1974 CHESS monograph.

†Now of Roth and Associates, statistical consultants to the Utility Air Regulatory Group, the Electric Power Research Institute, and the Edison Electric Institute.

Current Status of Independent CHESS Analyses (continued)

Requestor	Date Provided	Specific Study
Dr. Alice Whittemore Stanford University	1978	*California Asthma, 1972-73 *California Asthma, 1973-74 *California Asthma, 1974-75
Dr. Robert Mendelsohn Yale University	1976	New York CRD 1970 New York PFT 1970-71 New York Asthma 1970-71 New York Adult 1970-71 Utah CRD 1970 Utah LRD 1970 Chattanooga CRD 1971 Chattanooga LRD 1971 Chattanooga ARD 1972-73
Dr. Lyman Olsen Utah State Dept. of Health	1976	Utah Asthma 1970-71 Utah CRD 1970 Utah LRD 1970
Reed, Smith, Shaw & McClay, for American Iron & Steel Institute	1979	All Available Data Sets
Hunton and Williams, for Utility Air Regulatory Group	1979	All Available Data Sets

*Report or draft report on reanalyses prepared by requestors. Note that data sets with dates before 1972 were among those discussed in 1974 CHESS monograph.

APPENDIX C

PUBLISHED REPORTS RELATED TO CHESS

A. Pilot Studies (pre-CHESS)

1. Pearlman, ME; Finklea, JF; Creason, JP; Shy, CM; Young, MM; Horton, RJM: NITROGEN DIOXIDE AND LOWER RESPIRATORY ILLNESS. Pediatrics 47:391-398, February, 1971.

2. Shy, CM; Creason, JP; Pearlman, ME; McClain, KE; Benson, FB; Young, MM: THE CHATTANOOGA SCHOOL CHILDREN STUDY: EFFECTS OF COMMUNITY EXPOSURE TO NITROGEN DIOXIDE. I. METHODS, DESCRIPTION OF POLLUTANT EXPOSURE, AND RESULTS OF VENTILATORY FUNCTION TESTING. J. Air Pol. Control Assoc. 20(8): 539-545, August, 1970.

3. Shy, CM; Creason, JP; Pearlman, ME; McClain, KE; Benson, FB; Young, MM: THE CHATTANOOGA SCHOOL CHILDREN STUDY: EFFECTS OF COMMUNITY EXPOSURE TO NITROGEN DIOXIDE. II. INCIDENCE OF ACUTE RESPIRATORY ILLNESS. J. Air Pol. Control Assoc. 20(9): 582-588, September, 1970.

4. Cohen, AA; Bromberg, SM; Buechley, RW; Heiderscheit, LT; Shy, CM: ASTHMA AND AIR POLLUTION FROM A COAL-FUELED POWER PLANT. Am. J. Public Health 62(9): 1181-1188, September, 1972.

5. Hauser, TR; Shy, CM: POSITION PAPER: NO_x MEASUREMENT. Environmental Science and Technology 6(10): 890-894, October, 1972.

6. Shy, CM; Nelson, CJ; Benson, FB; Riggan, WB; Newill, VA; Chapman, RS: VENTILATORY FUNCTION IN SCHOOL CHILDREN: 1967-1968 TESTING IN CINCINNATI NEIGHBORHOODS. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 6-3 - 6-14. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

7. Finklea, JF; Goldberg, J; Hasselblad, V; Shy, CM; Hayes, CG: PREVALENCE OF CHRONIC RESPIRATORY DISEASE SYMPTOMS IN MILITARY RECRUITS: CHICAGO INDUCTION CENTER. 1969-1970. In: Health Consequences of Sulfur Oxides: A Report from CHESS. 1970-1971. EPA Report No. 65/1-74-4, pp. 4-23 - 4-36. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

8. Finklea, JF; French, JG; Lowrimore, GR; Goldberg, J; Shy, CM; Nelson, WC: PROSPECTIVE SURVEYS OF ACUTE RESPIRATORY DISEASE IN VOLUNTEER FAMILIES: CHICAGO NURSERY SCHOOL STUDY, 1969-1970. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 4-37+. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

9. Hinton, DO; English, TD; Parr, BF; Hasselblad, V; Dickerson, RC; French, JG: HUMAN EXPOSURE TO AIR POLLUTANTS IN THE CHICAGO-NORTHWEST INDIANA METROPOLITAN REGION, 1950-1971.

In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 4-3 - 4-22. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

10. Hayes, CG; Hammer, DI; Shy, CM; Hasselblad, V; Sharp, CR; Creason, JP; McClain, KE: PREVALENCE OF CHRONIC RESPIRATORY DISEASE SYMPTOMS IN ADULTS: 1970 SURVEY OF FIVE ROCKY MOUNTAIN COMMUNITIES. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 3-19 - 3-34. Research Triangle Park, N. C, EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

11. Finklea, JF; Hammer, DI; House, DE; Sharp, CR; Nelson, WC; Lowrimore, GR: FREQUENCY OF ACUTE LOWER RESPIRATORY DISEASE IN CHILDREN: RETROSPECTIVE SURVEY OF FIVE ROCKY MOUNTAIN COMMUNITIES, 1967-1970. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 3-35 - 3-54. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

12. English, TD; Sune, JM; Hammer, DI; Truppi, LA; Culver, WE; Dickerson, RC; Riggan, WB: HUMAN EXPOSURE TO AIR POLLUTANTS IN FIVE ROCKY MOUNTAIN COMMUNITIES, 1940-1970. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 3-3 - 3-17. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

B. Reports from CHESS Data Sets

1. Chapman, RS; Shy, CM; Finklea, JF; House, DE; Goldberg, HE; Hayes, CG: CHRONIC RESPIRATORY DISEASE IN MILITARY INDUCTEES AND PARENTS OF SCHOOLCHILDREN. Arch. Environ. Health 27(3): 138-142, September, 1973.

2. French, JG; Lowrimore, G; Nelson, WC; Finklea, JF; English, T; Hertz, M: THE EFFECT OF SULFUR DIOXIDE AND SUSPENDED SULFATES ON ACUTE RESPIRATORY DISEASE. Arch. Environ. Health 27(3): 129-133, September, 1973.

3. Shy, CM; Hasselblad, V; Burton, RM; Nelson, CJ; Cohen, AA: AIR POLLUTION EFFECTS ON VENTILATORY FUNCTION OF U. S. SCHOOL-CHILDREN. Arch. Environ. Health 27(3): 124-128, September, 1973.

4. Hammer, DI; Miller, FJ; Stead, AG; Hayes, CG: AIR POLLUTION AND CHILDHOOD LOWER RESPIRATORY DISEASE. I. EXPOSURE TO SULFUR OXIDES AND PARTICULATE MATTER IN NEW YORK, 1972. Clinical Implications of Air Pollution Research. AMA Air Pollution Medical Research Conference, December 5-6, 1974. Publishing Sciences Group, Inc., pp. 321-337, 1976.

5. Chapman, RS; Hasselblad, V; Hayes, CG; Williams, JVR; Hammer, DI: AIR POLLUTION AND CHILDHOOD VENTILATORY FUNCTION. I. EXPOSURE TO PARTICULATE MATTER IN TWO SOUTHEASTERN CITIES, 1971-1972. Clinical Implications of Air Pollution Research. AMA Air Pollution Medical Research Conference, December 5-6, 1974. Publishing Sciences Group, Inc., pp. 285-303, 1976.

6. Stebbings, JH; Hayes, CG: PANEL STUDIES OF ACUTE HEALTH EFFECTS OF AIR POLLUTION. I. CARDIOPULMONARY SYMPTOMS IN ADULTS, NEW YORK, 1971-1972. Environmental Research 11: 89-111, 1976.

7. Stebbings, JH: PANEL STUDIES OF ACUTE HEALTH EFFECTS OF AIR POLLUTION. II. A METHODOLOGIC STUDY OF LINEAR REGRESSION ANALYSIS OF ASTHMA PANEL DATA. Environmental Research 17: 10-32, 1978.

8. Nelson, CJ; Shy, CM; English, T; Sharp, CR; Andleman, R; Truppi, L; VanBruggen, J: FAMILY SURVEYS OF IRRITATION SYMPTOMS DURING ACUTE AIR POLLUTION EXPOSURES. J. Air Pol. Control Assoc. 23(2): 81-86, February, 1973.

9. Cohen, AA; Nelson, CJ; Bromberg, SM; Pravda, M; Ferrand, EF; Leon, G: SYMPTOM REPORTING DURING RECENT PUBLICIZED AND UNPUBLICIZED AIR POLLUTION EPISODES. Am. J. Public Health 64(5): 442-449, May, 1974.

*10. Hammer, DI: RESPIRATORY DISEASE IN CHILDREN EXPOSED TO SULFUR OXIDES AND PARTICULATES. EPA Report No. EPA-600/1-77-043, September, 1977.

11. Hasselblad, V: LUNG FUNCTION IN SCHOOL CHILDREN: 1971-1972 CHATTANOOGA STUDY. EPA Report No. EPA-600/1-77-002, January, 1977.

* Originally published as a Harvard University Ph.D. dissertation, prior to application of data validation procedures. Now being reexamined using validated data sets, as discussed at the August, 1980, CASAC meeting.

12. Decker, CE; Royal, TM: NITROGEN DIOXIDE TRENDS IN SELECTED CHATTANOOGA COMMUNITIES. EPA Report No. EPA-600/1-76-034, October, 1976.

13. House, DE; Finklea, JF; Shy, DM; Calafiore, DC; Riggan, WB; Southwick, JW; Olsen, LJ: PREVALENCE OF CHRONIC RESPIRATORY DISEASE SYMPTOMS IN ADULTS: 1970 SURVEY OF SALT LAKE BASIN COMMUNITIES. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 2-41 - 2-54. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

14. Goldberg, HE; Finklea, JF; Nelson, CJ; Steen, WB; Chapman, RS; Swanson, DH; Cohen, AA: PREVALENCE OF CHRONIC RESPIRATORY DISEASE SYMPTOMS IN ADULTS: 1970 SURVEY OF NEW YORK COMMUNITIES. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 5-33 - 5-48. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

15. Nelson, WC; Finklea, JF; House, DE; Calafiore, DC; Hertz, MB; Swanson, DH: FREQUENCY OF ACUTE LOWER RESPIRATORY DISEASE IN CHILDREN: RETROSPECTIVE SURVEY OF SALT LAKE BASIN COMMUNITIES. 1967-1970. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 2-55 - 2-74. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

16. Love, GJ; Cohen, AA; Finklea, JF; French, JG; Lowrimore, GR; Nelson, WC; Ramsey, PB: PROSPECTIVE SURVEYS OF ACUTE RESPIRATORY DISEASE IN VOLUNTEER FAMILIES: 1970-1971 NEW YORK STUDIES. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 5-7 - 5-49. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

17. Shy, CM; Hasselblad, V; Finklea, JF; Burton, RM; Pravada, M; Chapman, RS; Cohen, AA: VENTILATORY FUNCTION IN SCHOOL CHILDREN: 1970-1971. NEW YORK STUDIES. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 5-109 - 5-119. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

18. Finklea, JF; Calafiore, DC; Nelson, CJ; Riggan, WB; Hayes, CG: AGGRAVATION OF ASTHMA BY AIR POLLUTANTS: 1971 SALT LAKE BASIN STUDIES. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 2-75+. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

19. Finklea, JF; Farmer, JH; Love, GJ; Calafiore, DC; Sovocool, GW: AGGRAVATION OF ASTHMA BY AIR POLLUTANTS: 1970-1971 NEW YORK STUDIES. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 5-71 - 5-84. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

20. Goldberg, HE; Cohen, AA; Finklea, JF; Farmer, JH; Benson, FB; Love, GJ: FREQUENCY AND SEVERITY OF CARDIOPULMONARY SYMPTOMS IN ADULT PANELS: 1970-1971 NEW YORK STUDIES. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 5-85 - 5-108. Research Triangle Park, N. C., May, 1974 (Available from NTIS as PB-234 92/AS).

21. Hertz, MB; Truppi, LA; English, TD; Sovocool, GW; Burton, RM; Heiderscheit, LT; Hinton, DO: HUMAN EXPOSURE TO AIR POLLUTANTS IN SALT LAKE BASIN COMMUNITIES. 1940-1971. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 2-3 - 2-39. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

22. English, TD; Steen, WB; Ireson, RG; Ramsey, PB; Burton, RM; Heiderscheit, LT: HUMAN EXPOSURE TO AIR POLLUTION IN SELECTED NEW YORK METROPOLITAN COMMUNITIES, 1944-1971. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA 65/1-74-4, pp. 5-3 - 5-32. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

23. Finklea, JF; Shy, CM; Love, GJ; Hayes, CG; Nelson, WC; Chapman, RS; House, DE: HEALTH CONSEQUENCES OF SULFUR OXIDES: SUMMARY AND CONCLUSIONS BASED UPON CHESS STUDIES OF 1970-1971.

In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 7-3 - 7-24. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

24. Shy, CM; Riggan, WB; French, JG; Nelson, WC; Dickerson, RC; Benson, FB; Finklea, JF; Colucci, AV; Hammer, DI; Newill, VA: AN OVERVIEW OF CHESS. In: Health Consequences of Sulfur Oxides: A Report from CHESS, 1970-1971. EPA Report No. EPA-65/1-74-4, pp. 1-3 - 1-9. Research Triangle Park, N. C., EPA, May, 1974 (Available from NTIS as PB-234 92/AS).

*25. Shy, CM; Love, GJ; RECENT EVIDENCE ON THE HUMAN HEALTH EFFECTS OF NITROGEN DIOXIDE. In: Nitrogen Oxides and Their Effects on Health. S. D. Lee, Ed. Ann Arbor: Ann Arbor Science, pp. 291-305, 1980.

†26. Whittemore, AS; Korn, EL: ASTHMA AND AIR POLLUTION IN THE LOS ANGELES AREA. Amer. Jour. Pub. Health. 70(7): 687-696, July 1980.

*Proceedings of the Air Pollution Control Association Meeting in Hawaii, 1979.

†Discussed in context of demonstrating statistical validation procedures (see page 3 of this report).

C. General Reports Related To CHESS

1. Shy, CM; Finklea, JF; Calafiore, DC; Benson, F; Nelson, WC; Newill, VA: A PROGRAM OF COMMUNITY HEALTH AND ENVIRONMENTAL SURVEILLANCE STUDIES (CHESS). Determination of Air Quality, pp. 41-48. New York: Plenum Press, 1972.

2. Finklea, JF; Cranmer, MF; Hammer, DI; McCabe, LF; Newill, VA; Shy, CM: HEALTH INTELLIGENCE FOR ENVIRONMENTAL PROTECTION: A DEMANDING CHALLENGE. Proc. 6th Berkeley Symp. on Mathematical Statistics and Probability, July 19-22, 1971. Vol. 6, pp. 11-19. Berkeley: University of California Press, 1972.

3. Riggan, WB; Hammer, DI; Finklea, JF; Hasselblad, V; Sharp, CR; Burton, RM; Shy, CM: CHESS--A COMMUNITY HEALTH AND ENVIRONMENTAL SURVEILLANCE SYSTEM. Proc. 6th Berkeley Symp. on Mathematical Statistics and Probability, July 19-22, 1971. Vol. 6, pp. 125-133. Berkeley: University of California Press, 1972.

4. Nelson, WC; Hasselblad, V; Lowrimore, GR: STATISTICAL ASPECTS OF COMMUNITY HEALTH AND ENVIRONMENTAL SURVEILLANCE SYSTEM. Proc. 6th Berkeley Symp. on Mathematical Statistics and Probability, July 19-22, 1971. Vol. 6, pp. 125-133. Berkeley: University of California Press, 1972.

5. Hasselblad, V; Nelson, WC; Lowrimore, GR: ANALYSIS OF HEALTH EFFECTS DATA--SOME RESULTS AND PROBLEMS. Statistical and Mathematical Aspects of Pollution Problems, pp. 275-282. New York: Marcal Dekker, Inc., 1974.

6. Shy, CM; Finklea, JF: AIR POLLUTION AFFECTS COMMUNITY HEALTH. Environmental Science and Technology, 7: 204-208, March, 1973.

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APPENDIX D

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